Some observations concerning the reactions of the leaf hairs of Salvinia natans

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If one observes plants of *Salvinia natans* which are in an active condition, it will be observed that the hairs on the leaves show drops of liquid which they secrete. It was noticed from time to time that some of the leaves of the *Salvinia* which was kept growing in a large tub in the green-house bore small drops of dark colored liquid. Frequently a dead dipterous insect was found on the surface of a leaf somewhat enveloped in a white fungus which was also attached to the leaf hairs. These occurrences coupled with the superficial resemblance of the leaves of *Salvinia* to those of *Drosera* suggested the possibility that this fern might also be able to absorb food from decaying matter on the leaves. It was first desirable to see if organic matter would go into solution on the leaves of this plant.

Experiment 1. Two large battery jars of *Salvinia* were isolated from the tub and small soft-bodied dipterous and thysanuran insects, such as were found in and about the tub, were crushed and placed upon many of the leaves. By the end of a week all of these insects were covered with a white fungus, apparently the same as that previously noted on the *Salvinia* in the tub. During the second week almost all of this fungus disappeared and most of the inseits were reduced to drops of dark colored liquid. Only a few of the insects dried up. This experiment makes it entirely probable that some of the dark colored drops found on the leaves of the *Salvinia* in the tub contained organic remains. This reduction of the organic matter to a solution may have been the result of any or all of these three actions, (1) simple decomposition, (2) action by the *Salvinia* or (3) action by the fungus. Three experiments were made to ascertain whether or not the *Salvinia* contributes to this decomposition of the organic matter.

Experiment 2. Several large crystallizing dishes were filled with fresh *Salvinia*. On the surface of about every other leaf

was placed a small piece, approximately one millimeter cube, of the white of a hard boiled egg. The weight of the cubes was not great enough to break down the leaf hairs on which they rested. Similar cubes of the boiled white of egg were placed on clean glass in the dishes just above the surface of the water, as controls. During the first twenty-four hours all of the white of egg, both control and experiment, became rather transparent. At the end of forty-eight hours several of the leaves were removed and examined under a microscope. The cubes of egg had retained their shape perfectly, that is, there had been no rounding off of the edges as has been previously noted in the digestion of the white of egg by *Drosera*. A certain amount of the white of egg had been removed, however. Each of the leaf hairs on which the cube was resting had penetrated it and reached nearly through the block of boiled egg. The extreme tips of the prongs of each hair were thus firmly imbedded in the white of egg, but the remainder of the leaf hair scarcely touched the cube, being smaller than the chamber it occupied. This little chamber resembled a hole made in ice with a warm metal rod, being slightly larger than the leaf hair at every point except the tip. In addition to this reaction by the leaf hairs supporting the cube of white of egg, the row of hairs immediately around the cube which were not under it but which just touched it had also reacted. These hairs had bent in on all sides, penetrating the cube of white of egg in the same manner as those hairs on which the cube was resting, except that they entered the cube from the side; that is, there seemed to have been a positive chemotaxis on the part of the leaf hairs with reference to the white of egg. This experiment was continued for several days, with many plants and always with the result as just stated. Special precaution was necessary to keep the cubes of boiled egg from drying out too quickly. However, the white of egg did not injure the leaves in any way as far as could be determined during the six days it rested on them.

Experiment 3. Other cultures of *Salvinia* were isolated and small drops of *uncooked* white of egg placed on most of the leaves. Control drops of water of the same size were also placed on many leaves. The drops of both white of egg and water rested as tiny spheres on top of the leaf hairs for the first twenty-four hours.

During the second twenty-four hours the drops of white of egg in many instances broke, forming irregular patches which sank down to the surface of the leaf, completely surrounding the hairs which had supported them. At the same time the neighboring leaf hairs bent over into the white of egg in much the same manner as noted regarding the cubes of cooked white of egg. The control drops of water did not change meanwhile, remaining as spheres on top of the leaf hairs. Several things might have caused the drops of white of egg to act in this manner, but in the light of the solvent action of the leaf hairs on the cubes of cooked white of egg it seems probable that the leaf hairs themselves were responsible for the change which caused these drops of raw white of egg to change. These cultures were continued for eight days. During this time several of the drops of white of egg became infected with the white fungus already mentioned. The result was the same as that with the crushed insects. The white of egg became steadily more liquid until it was reduced to a fluid almost as mobile as water. By close observation it could be determined that in those cases where the tiny spheres of white of egg did not break and run down on to the surface of the leaf the amount of white of egg had decreased.

Experiment 4. On the leaves of fresh cultures of *Salvinia* drops of *uncooked* yellow of egg were placed. Controls were established by drops of the yellow of the egg being placed on clean glass in the dishes with the *Salvinia*, just above the surface of the water. The color of the egg on the leaves became noticeably paler than the control during the first twenty-four hours. At the end of forty-eight hours it had spread over a small area of the leaf surface in the same manner as the uncooked white of egg had done in the previous experiment. The color of this egg on the leaves was several shades lighter than the control and of a quite different consistency, being more like cream than the control. The same chemotaxis was displayed by the hairs surrounding the area covered by the egg.

Experiment 5. It was the object of this experiment to ascertain whether the plant was profiting by the presence of the decaying or soluble organic matter on the surface of its leaves. Four different jars of *Salvinia* were prepared.

In jar Number 1 the *Salvinia* was floated on distilled water.

In jar Number 2 on a nutrient solution containing the following substances:

Distilled water	1000.0 cc.
Potassium nitrate	1.0 gm.
Calcium sulphate	0.5 gm.
Magnesium sulphate	0.5 gm.
Sodium phosphate	0.5 gm.

Jar Number 3 contained a nutrient solution the same as that used in Number 2, except that the potassium nitrate was omitted. On the leaves of the *Salvinia* in this jar were placed cubes of cooked white of egg, drops of uncooked white of egg and crushed insects.

Jar Number 4 also contained a nutrient solution the same as Number 3, that is, without the potassium nitrate, but the leaves in this jar were free from foreign substances.

The *Salvinia* in jar Number 1 began to change color on the second day. The otherwise bright green color of the leaves became dull and by the fifth day there were distinct yellow spots on the leaves. In a week all of the leaves in this jar were of a uniform brownish-yellow color. In *Salvinia* care must be taken to keep the light conditions for good growth as nearly constant as possible. It frequently happens that *Salvinia* plants that have been growing in somewhat weak light will, when brought into very bright light, lose their green color and die. This, however, may be prevented by gradually bringing them into strong light which they may then stand without the least injury.

The plants in jar Number 2 remained quite normal throughout the entire experiment, which lasted fifteen days.

The leaves in jar Number 3 began to lose their color in six days and those in Number 4 four days. Both those with and without foreign matter on them finally lost all their color. By the end of the first week, however, there was a decided difference between the leaves in the two jars. Almost all of the leaves in both jars were turning yellow but those in jar Number 3 retained their color, especially, in the area immediately around that covered with organic matter. The ninth day all the leaves in both jars were yellow, excepting a few in jar Number 3. These few were still a little green in the area around the organic matter.

They continued to fade and by the fifteenth day all were entirely yellow.

This experiment shows that the plant can obtain a certain quantity of its food from the decomposing organic matter offered to it in the way above described. The amount that can be taken up by the leaf hairs, however, is small and is insufficient to supply the demands of the plant. The *Salvinia* with organic matter on its leaves seemed to have an advantage but this advantage in nature is only occasional or as chance offers.

Experiment 6. Pieces of cinder and iron filings were carefully laid on the leaves and allowed to remain for several days. No reaction of any sort occurred among the hairs of the leaves.

SUMMARY

One of the most interesting results was the chemotactic reaction of the leaf hairs. This was very distinct in every case, excepting experiment 6.

The experiments proved that the leaf hairs are capable of exerting a distinct solvent action on the organic matter placed on them. Experiments 2, 3 and 4 show this. This solvent action does not serve to remove any objectionable organic matter but the plant profits by the food derived by this action. The latter is well shown from the observations made, especially those of experiment 5. No experiment showed the leaves suffering from the presence of small amounts of organic matter on their leaves and on the contrary the leaves thus treated were the last to lose the green color as in experiment 5. The *Salvinia* may get only a small quantity of food in this way, as is indicated by the rapid decline of the plants even in experiment 5 when placed in a solution free of potassium nitrate. The positive chemotaxis of the leaf hairs, the solvent action on the cubes of cooked white of egg and the discoloring of the yellow of the raw egg coupled with the fact that in the normal habitat this fern frequently has the bodies of small soft insects which are finally dissolved on its leaves, shows at least that some food is taken in by these leaves when it is offered.

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